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TITLE: CIRCUIT PATTERN DETECTOR, CIRCUIT PATTERN DETECTING METHOD AND CIRCUIT PATTERN INSPECTING METHOD

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INVENTOR-INFORMATION:
NAME COUNTRY
YANAGISAWA, YASUYUKI

ASSIGNEE-INFORMATION:
NAME COUNTRY
TOPPAN PRINTING CO LTD

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ABSTRACT:

PROBLEM TO BE SOLVED: To provide an electric field intensity distribution detector which detects the field intensity distribution in the condition that the field intensity distribution is prevented from changing with the change of the voltage distribution of a highly integrated circuit pattern, by restricting the voltage distribution from spreading due to DC resistance components of distributed constants formed in a plane of an electro-optical element, and knows the electric characteristics about inspection of the short circuit/wire breaking on a circuit board from the voltage distribution or directly.

SOLUTION: The circuit pattern detector comprises electro-optical elements disposed with very small spacings or directly on a circuit board, a light source for irradiating the entire surface with a light, a signal source for applying a periodic zero sum voltage to the circuit board, and a light detector for detecting lights reflected from the electro-optical elements as a two-dimensional light intensity distribution. When an electric field is applied, this element changes its birefringence to change the polarization plane.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the circuit pattern detection equipment, the circuit pattern detection approach, and the circuit pattern inspection approach of inspecting the circuit pattern of the circuit board optically.
[0002]
[Description of the Prior Art] There is technique which forms an exclusive fixture with a spring probe, carries out package contact of the fixture to the pad of a circuit pattern, and is electrically inspected as the conventional technique which inspects an open circuit of the circuit pattern formed in the circuit board, a short circuit, etc. By this technique, in order to inspect the circuit pattern in recent years which the number of pads increased, many expensive spring probes are needed and the cost of an exclusive fixture soars. Moreover, damage on the pad by that it is physically difficult to secure the contact nature of a pad and contacting an acute spring probe also poses a problem by the densification of a pad.
[0003] Moreover, depending on the circuit board, a circuit pattern branches from one pad, and it may connect with two or more pads. In such a case, there is a problem from which the inspection time amount of an open circuit and a short circuit becomes huge.
[0004] Furthermore, although many circuit patterns may be formed over many layers depending on the circuit board, by the technique to which a spring probe is contacted, open circuit of such a circuit pattern of a multilayered circuit board and inspection of a short circuit are not made to a pad.
[0005] From such a background, the technique of detecting the distribution of voltage of a circuit pattern optically was desired. As a conventional example which measures the distribution of voltage of a circuit pattern using the electro-optical effect, the solder connection detection approach and detection equipment of electronic parts of a publication are in JP,9-72947,A. This detects the field strength of a specific location by non-contact using an electro-optics sensor, and inspects the solder connection condition of the circuit board. However, only the electric field for a point of an electro-optics sensor can be detected, but it is necessary to scan an electro-optics sensor in quest of the distribution of voltage of the whole circuit pattern by this approach.
[0006] On the other hand, the equipment which inspects open-circuit defects and short circuit defects, such as a pixel electrode of a liquid crystal display substrate, gate wiring, and source wiring, by non-contact by measurement of distribution of voltage is indicated by JP,5-256794,A. Here, the electro-optics component which has arranged the parallel flux of light near the circuit board is irradiated, and the distribution of voltage of a circuit pattern is detected two-dimensional from the reflected light.
[0007] However, since an electro-optics component has the high rate of a birefringence, an interference fringe arises by surface reflection and rear-face reflection, and the image of distribution of voltage for which it asked from the reflected light deteriorates remarkably.
[0008] The electro-optics component currently used especially by JP,5-256794,A is bismuthic acid-ized silicon, and has a photoconductivity remarkable in the light of wavelength shorter than 500nm. Therefore, the capacitive load which joins the dielectric reflective film of an electro-optics component

falls, and it is easy to produce dielectric breakdown on the dielectric reflective film. Also in other electro-optics components, the same thing might arise with the wavelength property.
[0009] Moreover, when an electrical potential difference is impressed to the circuit pattern of the circuit board, the charge to the direction of a field is spread within an electro-optics component, and there is an inclination for distribution of voltage to deteriorate. That is, when an electrical potential difference was impressed to the circuit pattern of the circuit board, there was a trouble that the distribution of voltage of the circuit pattern of the circuit board spread for an electro-optics component by the direct-current-resistance component to the direction of a field and the direct-current-resistance component which the reflecting layer of an electro-optics component has especially.
[0010]
[Problem(s) to be Solved by the Invention] Thus, conventional circuit pattern test equipment has the fault that distribution of voltage of the whole circuit pattern cannot be searched for at once. Moreover, when an electrical potential difference is impressed to the circuit pattern of the circuit board, the charge to the direction of a field is spread for the electro-optics component used for this within an electro-optics component, and it has the fault in which distribution of voltage deteriorates.
[0011] The purpose of this invention detects optically the distribution of voltage of the circuit pattern formed on the circuit board with a sufficient precision, and is to offer the circuit pattern detection equipment and the circuit pattern inspection approach of inspecting a short circuit/open circuit of a circuit pattern.
[0012]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem and to attain the purpose, this invention offers the means shown below.
[0013] The electro-optics component from which plane of polarization changes according to the rate of a birefringence which was prepared in the invention in this application concerning invention of claim 1 near [in which the circuit pattern was formed] the circuit board, and changed according to electric field, The electrical-potential-difference impression circuit which impresses a periodic 0 sum electrical potential difference between a circuit pattern and said electro-optics component in order to give the electric field according to a circuit pattern to said electric element, The circuit pattern detection equipment possessing the light source which irradiates light to said electro-optics component, and the detector which detects the intensity distribution of the reflected light of said electro-optics component is offered.
[0014] In the invention in this application concerning invention of claim 2, the circuit pattern detection equipment according to claim 1 characterized by detecting is offered synchronizing with impression of said electrical-potential-difference impression circuit.
[0015] In the invention in this application concerning invention of claim 3, the circuit pattern detection equipment according to claim 1 or 2 characterized by said periodic 0 sum electrical potential difference containing step voltage is offered.
[0016] In the invention in this application concerning invention of claim 4, the circuit pattern detection equipment according to claim 1 or 2 characterized by said periodic 0 sum electrical potential difference containing a pulse voltage is offered.
[0017] In the invention in this application concerning invention of claim 5, the circuit pattern detection equipment according to claim 1 or 2 characterized by said periodic 0 sum electrical potential difference containing alternating voltage is offered.
[0018] In the invention in this application concerning invention of claim 6, said electrical-potential-difference impression circuit grounds said electro-optics component, and offers the circuit pattern detection equipment of a publication 5 either from claim 1 possessing the source of a signal which impresses a periodic 0 sum electrical potential difference to said circuit pattern.
[0019] In the invention in this application concerning invention of claim 7, said electrical-potential-difference impression circuit grounds said circuit pattern, and offers the circuit pattern detection equipment of a publication 5 either from claim 1 possessing the source of a signal which impresses a periodic 0 sum electrical potential difference to said electro-optics component.

[0020] In the invention in this application concerning invention of claim 8, said electro-optics component offers the circuit pattern detection equipment of a publication 7 either from claim 1 characterized by providing the acid-resisting layer prepared between the electro-optics crystal layer, the transparent electrode layer prepared in the optical incidence side of said electro-optics crystal layer, and said electro-optics crystal layer and said transparent electrode layer.
[0021] In the invention in this application concerning invention of claim 9 said electro-optics component An electro-optics crystal layer and the transparent electrode layer prepared in the optical incidence side of said electro-optics crystal layer, The adhesives layer prepared between said electro-optics crystal layers and said transparent electrode layers, The circuit pattern detection equipment of a publication is offered 7 either from claim 1 possessing the 2nd acid-resisting layer prepared between the 1st acid-resisting layer prepared between said electro-optics crystal layers and said adhesives layers, and said transparent electrode layer and said adhesives layer.
[0022] In the invention in this application concerning invention of claim 10, the circuit pattern detection equipment of a publication is offered 9 either from claim 1 which possesses further the beam splitter prepared between said light sources and said electro-optics components, the wavelength plate formed between said beam splitters and said light sources (1/8), and the wavelength plate formed between said beam splitters and said detectors (1/8).
[0023] In the invention in this application concerning invention of claim 11, the circuit pattern detection equipment of a publication is offered 9 either from claim 1 characterized by providing independently the optical system which irradiates light from said light source to said electro-optics component, and the optical system between the detectors which detect the intensity distribution of the reflected light of said electro-optics component to said electro-optics component.
[0024] In the invention in this application concerning invention of claim 12, the circuit pattern detection equipment of a publication is offered 11 either from claim 1 characterized by providing further the wavelength filter to which it is supposed that the wavelength said electro-optics component indicates the photoelectric effect to be between said light sources and said electro-optics components is not included.
[0025] In the invention in this application concerning invention of claim 13, the circuit pattern detection equipment of a publication is offered 11 either from claim 1 to which said light source is characterized by not including the wavelength said electro-optics component indicates the photoelectric effect to be.
[0026] In the invention in this application concerning invention of claim 14, the circuit pattern detection equipment according to claim 12 or 13 characterized by performing acid-resisting processing of said electro-optics component to transmitted wave length other than the wavelength made into said thing [not containing] is offered.
[0027] In the invention in this application concerning invention of claim 15, the circuit pattern detection equipment according to claim 14 with which said electro-optics component is characterized by performing acid-resisting processing to an electro-optics crystal and the dielectrics of each including an electro-optics crystal and a dielectric is offered.
[0028] In the invention in this application concerning invention of claim 16 A periodic 0 sum electrical potential difference is impressed between the electro-optics component prepared near [in which the circuit pattern to inspect was formed] the circuit board, and said circuit board. Generate electric field and the rate of a birefringence of said electro-optics crystal layer is changed according to a circuit pattern by this electric field. The circuit pattern detection approach of irradiating light at said electro-optics component, detecting the reflected light from said electro-optics component, and detecting the distribution-of-voltage pattern between said circuit board and an electric electro-optics crystal layer is offered.
[0029] In the invention in this application concerning invention of claim 17, the circuit pattern detection approach according to claim 16 that detection of the reflected light from said electro-optics component is interlocked with the period of said periodic 0 sum electrical potential difference, and is characterized by being detection of the reflected light from said electro-optics component is offered.
[0030] In the invention in this application concerning invention of claim 18, the circuit pattern detection approach according to claim 16 or 17 which carries out that said electro-optics component is grounded is

offered.
[0031] In the invention in this application concerning invention of claim 19, the circuit pattern detection approach according to claim 16 or 17 which carries out that said circuit board is grounded is offered.
[0032] In the invention in this application concerning invention of claim 20, the pattern detection approach given in 19 is offered from claim 16 characterized by the phase contrast of the light which irradiated said electro-optics component, and the reflected light from said electro-optics component being 1/8 of wavelength.
[0033] In the invention in this application concerning invention of claim 21, the pattern detection approach given in 19 is offered from claim 16 characterized by the optical system of the reflected light from said electro-optics component differing from the optical system which irradiates light to said electro-optics component.
[0034] In the invention in this application concerning invention of claim 22, the light which irradiates light to said electro-optics component offers the pattern detection approach given in 21 from claim 16 characterized by said electro-optics component not containing the wavelength which causes the photoelectric effect.
[0035] In the invention in this application concerning invention of claim 23, the light which irradiates light to said electro-optics component offers the pattern detection approach given in 22 from claim 16 characterized by carrying out acid resisting in said electro-optics component.
[0036] the invention in this application concerning invention of claim 24 -- setting -- claims 16-23 -- the inspection approach of the pattern characterized by carrying out the comparison test of the distribution-of-voltage pattern detected by which pattern inspection approach and the criteria distribution is offered.
[0037]
[Embodiment of the Invention] With reference to a drawing, the gestalt of operation of this invention is explained below.
[0038] The field strength distribution detection equipment which enforces the approach of this invention first is explained according to drawing 1 .
[0039] The electro-optics component 1 is arranged on the circuit board 2, and beam PURITTA 7, a polarizer 5, and a laser light source 4 are arranged in order above this electro-optics component 1.
[0040] Moreover, the photodetector 9 is formed in the horizontal location of beam PURITTA 7 through the analyzer 8.
[0041] In this photodetector 9, one side has connected another side to a control unit 11 through analysis equipment 10 at direct control equipment 11.
[0042] And it has connected with a control unit 11 through the source 3 of a signal at the circuit board 2.

[0043] Moreover, the electro-optics component 1 is arranged near the circuit board 2.
[0044] At this time, the electro-optics component 1 may be contacted to the circuit board 2, and may be arranged in the location in which minute spacing was prepared.
[0045] Minute spacing means spacing of the range which electric field generate for an electro-optics component, when an electrical potential difference is impressed to a circuit pattern, for example, it is good also as non-contact in the distance of about 20 micrometers.
[0046] As an electro-optics component 1, it consists of the dielectric reflecting layer 1-1, an electro-optics crystal layer 1-2, and an electrode 1-3, and there is for example, a POKKERUSU crystal etc. as this electro-optics crystal layer.
[0047] When detecting electric field with light using a POKKERUSU crystal, there are horizontal electric-field detection which has sensibility in the electric field of a direction perpendicular to light, and vertical electric-field detection which has sensibility in the electric field of a direction parallel to light.
[0048] Here, in order to detect electric-field distribution correctly according to the configuration of the distribution of voltage generated in the circuit board, it carries out by vertical electric-field detection.
[0049] As a POKKERUSU crystal which can carry out vertical electric-field detection, KDP (KH2PO4, hydrogen potassium phosphate), KTP (KTiOPO4, phosphoric-acid titanyl potassium), ZnSe, BSO (Bi12SiO20, bismuthic acid-ized silicon), GaAs (gallium arsenide), a three to 55 LiNbO(s) cut, etc. are

used.
[0050] KDP and KTP have deliquescence here and ZnSe, GaAs, etc. have the low value of an electrooptic coefficient.
[0051] Then, although a refractive index is high, there is no deliquescence, is a cubic, has an isotropic property, and is desirable. [of BSO crystal with a comparatively large electrooptic coefficient]
[0052] For example, grind desirably about 1-30mm BSO crystal in thickness of 100-500 micrometers, the ITO film is made to deposit on a base at the dielectric reflecting layer and plane-of-incidence side of light, and it considers as an electro-optics component.
[0053] Since the potential difference becomes it small that BSO crystal is less than 100 micrometers, the detection sensitivity of electric field becomes small.
[0054] When 500 micrometers is exceeded, it becomes moreover, less easy for the direction of a field for electric field to detect breadth and distribution of voltage.
[0055] Moreover, the POKKERUSU crystal from which a refractive index changes can also be used as other examples of an electro-optics component with the magnitude of the electric field which act.
[0056] In addition, as optical crystal used for the electro-optics component 1 used by this invention, if a refractive index changes, the electrode 1-3 which consists of ITO film which may use not only the aforementioned thing but which thing will be one electrode among the above-mentioned electro-optics components.
[0057] When this ITO film 1-3 is grounded to a gland and alternating voltage is impressed from the source 3 of a signal, electric field occur between the circuit patterns 2-1 of the circuit board 2.
[0058] The refractive index of the electro-optics crystal 1-2 which constitutes an electro-optics component by the generated electric field changes.
[0059] The timing of the alternating-voltage impression by the source 3 of a signal and the detection timing of a photodetector are controlled by the control unit 11.
[0060] The light source can use the halogen light source besides a laser light source, the meta-halide light source, etc.
[0061] The laser beam by which incidence is carried out is taken as a laser beam bundle two-dimensional by the beam expander 5 etc. from a laser light source 4 to the electro-optics component 1.
[0062] A laser beam bundle polarizes with a polarizer 6, and carries out incidence to the electro-optics component 1.
[0063] The laser beam bundle which carried out incidence to the electro-optics component 1 is reflected by the dielectric reflective film 1-1, and a polarization condition changes with change of the refractive index in the electro-optics crystal 1-2.
[0064] The polarization angle at this time becomes settled according to the electro-optics tensor of an electro-optics crystal, and the direction of the electric field vector to detect.
[0065] At this time, as for a laser beam bundle, a polarization condition changes according to the distribution of voltage of the circuit pattern 2-1.
[0066] Incidence of the laser beam bundle which incidence of the laser beam bundle from which the plane of polarization by which outgoing radiation was carried out from the electro-optics component 1 changed was carried out to the beam splitter 7, among these branched perpendicularly is carried out to an analyzer 8.
[0067] The laser beam bundle which carried out outgoing radiation from the analyzer 8 has the optical intensity distribution according to the distribution of voltage of the circuit pattern 2-1.
[0068] A polarizing plate etc. can be used as an analyzer.
[0069] By detecting this laser beam bundle with a photodetector 9, the distribution of voltage of the circuit pattern 2-1 is approximated with two-dimensional optical intensity distribution, thing detection can be carried out and there are very few differences from distribution of voltage with an actual electrical property.
[0070] CCD etc. can be used as a photodetector.
[0071] Defects, such as an open circuit of the circuit pattern 2-1 and a short circuit, can be inspected by analyzing and processing the distribution of voltage detected with the photodetector 9 with analysis

equipment 10 as occasion demands.
[0072] The example of inspection at the time of using the test equipment shown in drawing 1 here is explained.
[0073] The principle which inspects an open circuit and short circuit of the circuit board from an electric-field image is shown in drawing 2 .
[0074] In drawing 2 , the electro-optics component 22 is arranged to the circuit pattern 21 seen from the top face.
[0075] Electrical characteristics can detect the short circuit section 25 and the open-circuit section 26 by the compare check with the electric-field image 23 by the faulty electric-field image 24 to the excellent article electrical characteristics electric-field image 23.
[0076] The flow chart which carries out electric inspection of the circuit board from an electric-field image is shown in drawing 3 .
[0077] In processing 28, directions are taken out from a control unit 11 to the source 3 of a signal, and alternating voltage is impressed to a circuit pattern.
[0078] At this time, an electric-field image is detected with a photodetector 9 according to the configuration of electric-field distribution of a circuit pattern.
[0079] In processing 29, image detection directions are taken out from a control unit 11 to a photodetector 9.
[0080] The detected image is transmitted to analysis equipment 10 by processing 30.
[0081] The stray light besides the component of an electric-field image exists in the image captured by processing 30 to analysis equipment 10.
[0082] Then, difference with the image of only the stray light which does not contain an electric-field image component is taken, and a stray light component is oppressed.
[0083] In processing 31, the directions which stop alternating voltage are taken out from a control unit 11 to the source 3 of a signal.
[0084] In processing 32, image detection directions are taken out from a control unit 11 to a photodetector 9.
[0085] The detected image is transmitted to analysis equipment 10 in processing 33.
[0086] In processing 34, with analysis equipment 10, the stray light is oppressed by taking the difference of the image data incorporated by processing 30 and processing 33, and an electric-field image is extracted.
[0087] Electric inspection of a circuit pattern is carried out by the compare check of the electric-field image for which it asked by processing 34 by processing 35, and the electric-field image of the excellent article searched for beforehand.
[0088] Moreover, as shown in drawing 8 , the inspection same also as a configuration which connected the source 3 of a signal to the electro-optics component 1 instead of the circuit board 2 is possible.
[0089] And as shown in drawing 9 , sensibility when impressing an electrical potential difference can be **(ed) in ** by considering as the configuration which formed 1/8 wavelength plate 14 between beam PURITTA 7 and an analyzer 8.
[0090] By regarding it as the equal circuit property of the direction of a field in the electro-optics component 1 here, and taking into consideration, distribution of voltage is detectable with sufficient spatial resolving power.
[0091] Furthermore, the electrical-potential-difference value in which the periodic 0 sum electrical potential difference carried out the periodic integral is zero, and there is no dc-component electrical potential difference.
[0092] A pulse, a step, a sign curve (alternating current wave form), etc. can use a wave at the moment.
[0093] The following examples explain the detail.
[0094]
[Example] "Example 1" The example of this invention according to claim 1 is explained using drawing 1 and drawing 4 .
[0095] In drawing 1 , although electrical characteristics carry out distributed constant circuit-work to the

interior of the electro-optics component 1 (reflecting layer which consists of the transparence substrate / glass substrate / epoxy adhesive layer / a BSO electro-optics crystal layer / SiO2-TiO2 which consists of ITO), since the reactance component (capacity induction component) of the direction of a flat surface and a vertical immittance component (direct-current-resistance component) can be disregarded even if it uses an equal circuit, an equal circuit like drawing 4 (a) is formed.

[0096] By the capacitor component of the electro-optics crystal layer formed between the reflective film and the ITO film, it has a low pass property in the direction of a field.

[0097] Therefore, a capacitor component, C2, C3 which the electrical potential difference V1 joined the capacitor component C1 near the circuit pattern through the capacitor component Cair of an air space from the circuit pattern, and were far apart in the direction of a field one by one like drawing 4 (b) when step voltage was impressed from the source 3 of a signal -- They are electrical potential differences V2 and V3 to Cn. -- Vn is added.

[0098] When direct current voltage is impressed to the circuit pattern 2-1 of the above-mentioned equipment, since distribution of voltage will spread and will be detected, circuit distribution cannot be detected with a photodetector 9.

[0099] Thus, the distribution of voltage impressed with sufficient resolution to the circuit pattern 2-1 is detectable by impressing alternating voltage and oppressing the diffusion to the direction of a field of a charge from the equal circuit of drawing 4 (a).

[0100] "Example 2" The example of this invention according to claim 2 is explained using drawing 1 and drawing 5 .

[0101] Alternating voltage is impressed like drawing 5 (a) from the source 3 of a signal. Here, synchronizing with the time of the absolute value of alternating voltage becoming large like drawing 5 (b), timing is controlled by the control unit 11 and photodetection equipment 9 detects the reflected light from the electro-optics component 1.

[0102] When the absolute value of alternating voltage is large, the reinforcement of the distribution of voltage detected also becomes large. This to sensibility is good, the distributed constant of the direction of a field of the electro-optics component 1-1 is uninfluential, and distribution of voltage can be detected.

[0103] In the data of two or more optical intensity distributions detected with photodetection equipment 9 still like drawing 5 synchronizing with alternating voltage, a S/N ratio can be improved addition-izing and by equalizing with analysis equipment 10, and distribution of voltage can be detected as optical intensity distribution.

[0104] Others are the same as that of an example 1.

[0105] "Example 3" The example of this invention according to claim 3 is explained using drawing 1 and drawing 6 .

[0106] Step voltage is impressed like drawing 6 (a) from the source 3 of a signal. Here, like drawing 6 (b), synchronizing with the impression timing of step voltage, timing is controlled by the control unit 11 and a photodetector 9 detects the reflected light from the electro-optics component 1.

[0107] Thereby, resolution is good and distribution of voltage can be detected without the effect by diffusion of the charge in the electro-optics component 1 as optical intensity distribution.

[0108] In addition, by the dc component of this electrical potential difference, since electric-field distribution is not extinguished, step voltage is impressed and it detects in a transient phase.

[0109] Others are the same as that of an example 1.

[0110] "Example 4" The example of this invention according to claim 4 is explained using drawing 1 and drawing 7 .

[0111] A pulse voltage is impressed like drawing 7 (a) from the source 3 of a signal.

[0112] Here, like drawing 7 (b), synchronizing with the impression timing of a pulse voltage, timing is controlled by the control unit 11 and photodetection equipment 9 detects the reflected light from the electro-optics component 1.

[0113] Thereby, resolution is good and distribution of voltage can be detected without the effect by diffusion of the charge in the electro-optics component 1 as optical intensity distribution.

[0114] Moreover, step voltage is continuously impressed like drawing 7 (c) from the source 3 of a signal, and photodetection equipment 9 detects the reflected light from the electro-optics component 1 synchronizing with the impression timing of step voltage by controlling timing by the control unit 11 like drawing 7 (d). It sets up so that the charge which generates the period Toff when the electrical potential difference of drawing 5 (c) is not impressed at this time for the capacitor component of the electro-optics crystal 1-2 may discharge.
[0115] Thereby, resolution is good and distribution of voltage can be detected without the effect by diffusion of the charge in the electro-optics component 1 as optical intensity distribution.
[0116] Here, synchronizing with the pulse voltage impressed continuously, S/N is good addition-izing and by equalizing with analysis equipment 10 in the data of two or more optical intensity distributions detected with photodetection equipment 9, and distribution of voltage can be detected as optical intensity distribution.
[0117] Moreover, by impressing a pulse voltage equal to positive/negative like drawing 7 (e) from the source 3 of a signal, and detecting the reflected light from the electro-optics component 1 with photodetection equipment 9 synchronizing with impression timing, similarly, resolution is good in distribution of voltage, it can improve and a S/N ratio can be detected.
[0118] In addition, by the dc component of this electrical potential difference, since electric-field distribution is not extinguished, step voltage is impressed and it detects in a transient phase.
[0119] Others are the same as that of an example 1.
[0120] "Example 5" The example of this invention according to claim 5 is explained using drawing 8 .
[0121] Like drawing 8 , the circuit pattern 2-1 is grounded electrically, and alternating voltage is impressed to the transparence electric conduction film 1-3 which consists of ITO film of the electro-optics component 1 of the same configuration as an example 1 from the source 12 of a signal. At this time, between a transparent electrode 1-3 and the circuit pattern 2-1, electric field occur and electric-field distribution can be detected as optical intensity distribution in the touch-down criteria of the circuit pattern 2-1, and the part which has flowed.
[0122] Others are the same as that of an example 1.
[0123] "Example 6" The example of this invention according to claim 6 is explained using drawing 9 and drawing 10 .
[0124] In drawing 9 , 1/8 wavelength plate 13 and 1/8 wavelength plate (**) 14 are installed, respectively between a polarizer 6 and a beam splitter 7 and between an analyzer 8 and a beam splitter 7, and 1/8 wave and phase contrast are given for the plane of polarization of the incident light to the electro-optics component 1, and outgoing radiation light.
[0125] When this impresses an electrical potential difference to the circuit pattern 2-1, the relation between applied voltage and optical reinforcement serves as the electrical-potential-difference-light strength property 16 from the electrical-potential-difference-light strength property 15 of drawing 10 , and the sensibility when impressing an electrical potential difference becomes high.
[0126] At this time, alternating voltage is impressed to the circuit pattern 2-1, and photodetection equipment 9 detects optical intensity distribution by controlling timing by the control unit 11 synchronizing with the timing which the forward electrical potential difference and the negative electrical potential difference joined. With analysis equipment 10, by taking the difference of optical intensity distribution when a forward electrical potential difference and a negative electrical potential difference are added, sensibility and resolution are good and distribution of voltage can be detected as optical intensity distribution.
[0127] Furthermore, a S/N ratio can be improved addition-izing and by equalizing with analysis equipment 10 in the data of two or more optical intensity distributions detected with photodetection equipment 9 synchronizing with alternating voltage, and distribution of voltage can be detected as optical intensity distribution.
[0128] Others are the same as that of an example 1.
[0129] It explains using "example 6" drawing 11 . The electro-optics component 1 forms the dielectric reflective film 1-1 in the electro-optics component 1-2 which consists of BSO crystal. The transparent

electrode 1-3 which becomes the transparence substrate 1-5 from ITO is formed, and the electro-optics crystal 1-2 which consists of BSO crystal is pasted in the adhesives layer 1-4.
[0130] The electro-optics component 1 is arranged near the circuit board 2 used as a subject of examination. At this time, the electro-optics component 1 may be contacted to the circuit board 2, and is good also as non-contact in the distance of about 20 micrometers. When a transparent electrode 1-3 is grounded to a gland and alternating voltage is impressed from the source 3 of a signal, electric field occur between the circuit pattern 2-1 and a transparent electrode 1-3. By impressing alternating voltage, diffusion of the charge produced in the direction of a field of the electro-optics component 1 is oppressed, and the distribution of voltage of the circuit pattern 2-1 can be detected with high spatial resolving power.
[0131] The distribution of voltage of the circuit pattern 2-1 is detectable with resolution between altitude using for the electro-optics component 1 the electro-optics crystal 1-2 which can detect vertical electric field. The electric field generated with alternating voltage permeate the electro-optics crystal 1-2, and a refractive index changes.
[0132] In case distribution of voltage is detected, the quantity of light is large, and since it has the wavelength property of a broadband, the white lights which interference cannot generate easily in an electro-optics component, such as halogen light and METAHARA light, are desirable. The white light by which outgoing radiation was carried out from the light source 4 is the wavelength filter 41, and the electro-optics crystal 1-2 serves as incident light which does not show the photoconductive effect. Since the electro-optics crystal 1-2 generally shows the photoconductive effect remarkable in light with a wavelength of 500nm or less, light 500nm or less cuts it about. Thereby, as the electro-optics crystal 1-2, it is not generated but the fall of the resistance by the photoconductive effect can prevent electric destruction of dielectric breakdown when alternating voltage is impressed to the dielectric reflective film 1-1 etc.
[0133] Incident light polarizes with a polarizer 6 and carries out incidence to the electro-optics component 1. The incident light to the electro-optics component 1 is reflected by the dielectric reflective film 1-1, and a polarization condition changes according to change of the refractive index by the electric field in the electro-optics crystal 1-2. At this time, as for the reflected light, optical distribution of a polarization condition changes according to the distribution of voltage of the circuit pattern 2-1.
[0134] The alternating-voltage impression by the source 3 of a signal, the incident light exposure by the light source 4, and the detection timing by the photodetector 9 are controlled by the control unit 11. The reflected light is intersecting an analyzer 8 perpendicularly with a polarizer 6, and detects the reflected light from which the polarization condition by electric field changed as luminous-intensity distribution. By using two-dimensional image sensors, such as CCD, for a photodetector 9, the distribution of voltage of the circuit pattern 2-1 is detected as an image. By comparing the detected image with the electric-field image of an excellent article with analysis equipment 10, the electrical potential difference of a circuit pattern can be inspected as an image.
[0135] Others are the same as that of an example 1.
[0136] The "example 7" example 7 is explained using drawing 12 .
[0137] In order to detect the distribution of voltage of the circuit pattern 2-1 with high spatial resolving power, it is effective to prevent interference generated with the electro-optics component 1. Then, acid-resisting processing is performed to the plane-of-incidence side of the transparence substrate 1-5 between the layers of the electro-optics component 1.
[0138] The electro-optics crystal 1-2 which consists of BSO crystal has a refractive index as high as 2.55, a refractive index is about 1.5 and the adhesives layer 1-4 forms the antireflection film 1-6 for adhesives which prevents reflection between the layers by the refractive-index difference. Since the refractive index of the transparent electrode 1-3 which consists of ITO film similarly is about 1.9, it forms the antireflection film 1-7 for a transparent electrode between the adhesives layers 1-4. The substrate antireflection film 1-8 for transparence is formed similarly. Furthermore, the antiaircraft mind antireflection film 1-9 is formed in the transparence substrate 1-5.
[0139] The incident light to the electro-optics component 1 has the wavelength band where the light of

the light source 4 penetrates the wavelength filter 5.
[0140] Interference can be oppressed by uniting acid-resisting processing with the wavelength of the incident light to the electro-optics component 1.
[0141] Incident light has a specific wavelength band. On the wavelength which the dielectric reflective film 1-1 does not reflect here, incident light penetrates, it is a photodetector 9 and the image of the circuit board 2 will be detected. By it, the detection sensitivity of distribution of voltage will change with locations. Then, the distribution of voltage of the circuit pattern 2-1 is detectable without the nonuniformity of the sensibility by the location by making the wavelength band which the dielectric reflective film 1-1 reflects into the property of reflecting all the wavelength bands of incident light.
[0142] Others are the same as that of an example 6.
[0143] Since interference, a speckle, etc. occur with the electro-optics component 1 when coherent light is used as the "example 8" light source 4, incoherent light is used. However, since the electro-optics crystal 1-2 which consists of BSO crystal has the photoconductive effect, if light with a wavelength of 500nm or less is irradiated, the capacitive load which joins the dielectric reflective film 1-1 will fall, and damages, such as dielectric breakdown, will produce it. Then, by things for which BSO crystal 1-2 uses the light of the wavelength which does not show the photoconductive effect, such as red and the orange LED light source, interference with the electro-optics component 1 and effect of a speckle are lessened, and distribution of voltage can be detected without the effect of the photoconductive effect.
[0144] Others are the same as that of an example 6.
[0145] An "example 9" beam splitter or wavelength filter was not prepared, either, but the optical system which irradiates light from the light source to said electro-optics component, and the optical system between the detectors which detect the intensity distribution of the reflected light of said electro-optics component to said electro-optics component were made to provide independently.
[0146] in this case, incident light and the reflected light do not become the same -- it is shown in drawing 13 like -- as -- each optical system -- slant -- incidence -- it constituted so that it might reflect.
[0147] Others are the same as that of an example 6.
[0148] "Example 10" drawing 14 shows the outline of another example. This example consists of the electrical-potential-difference feeder 110, the contact probe 112, the circuit board 114, electrical-potential-difference detection equipment 116, judgment equipment 118, the electro-optics probe (EO probe) 120, the light source 122, an optical-system device 124, photodetection equipment 126, and a control unit 128.
[0149] First, an electrical potential difference is impressed to the predetermined pad 130 by the side of the extensive pitch of the circuit board 114 through the contact probe 112 from the electrical-potential-difference feeder 110. At this time, electrical-potential-difference detection equipment 116 detects the electrical potential difference of other pads by the side of an extensive pitch, and the electrical condition (short circuit) of the circuit pattern 132 of the circuit board 114 is inspected with judgment equipment 118.
[0150] Next, the electro-optics probe 120 is laid at the predetermined spacing near the pad 134 group by the side of a ** pitch. At this time, the electro-optics probe 120 may be contacted to the pad 134 by the side of a ** pitch, or the circuit pattern 132 near a pad, and may be made non-contact at intervals of about 20 micrometers. Furthermore, the light from the light source 122 polarizes by the optical-system device 124, and is irradiated to the electro-optics probe 120.
[0151] If an electrical potential difference is impressed from the pad 130 by the side of an extensive pitch, when the circuit pattern 132 will not be disconnected, the electro-optics probe 120 detects the electric field from the pad 134 by the side of a ** pitch. As for the reflected light from the electro-optics probe 120, a polarization condition changes with the electric fields from the pad 134 by the side of a ** pitch at this time. Luminous-intensity change becomes irregular by the optical-system device 124, the polarization component which changed with electric fields is detected by photodetection equipment 126, and it becomes possible by judging luminous intensity with judgment equipment 118 to inspect the electrical condition (open circuit) of a circuit pattern.
[0152] the above -- actuation of these single strings is controlled by the control unit 128.

[0153] "Example 11" drawing 15 (a) and (b) show an example of inspection of another example. This inspection inspects the electrical condition (a short circuit/open circuit) of the tape BGA (ball grid array) on which the pad 134 and the circuit pattern 136 were formed on the insulating film 132. The electrical condition (a short circuit/open circuit) of the circuit pattern 136 can be inspected at once, without moving the electro-optics probe 120, if the electro-optics probe 120 is laid in the point of the circuit pattern 136 of Tape BGA and an electrical potential difference is impressed from a pad 134.
[0154]
[Effect of the Invention] According to the equipment of this invention, degradation of the spatial resolving power by the distributed constant circuit property formed in the direction of a field of an electro-optics component in the distribution of voltage of the circuit pattern of the circuit board can be oppressed and detected by the approach adapting the electro-optical effect. By analyzing this distribution of voltage, it becomes detectable [which it is useful to an electric inspection of an open circuit/short circuit of the circuit board integrated highly].
[0155] According to the equipment of this invention, distribution of voltage is detectable as two-dimensional field strength distribution only by arranging an electro-optics component on the circuit pattern of the circuit board. If the detected field strength distribution is used, an electric inspection can be carried out by the simple positioning system at an early detection rate by comparing and judging field strength distribution of an excellent article.
[0156] By the approach of this invention, by impressing and detecting a periodic 0 sum electrical potential difference, for example, alternating voltage, to the circuit pattern of the circuit board, such a property is improved and it can detect with sufficient distribution-of-voltage spatial resolving power.
[0157] Moreover, the circuit pattern of the circuit board can detect distribution of voltage similarly by applying a periodic 0 sum electrical potential difference, for example, alternating voltage, to the ITO film of an electro-optics component, even when it grounds.
[0158] There are advantages, like by this, by a shorting bar etc., the circuit pattern of the circuit board is contacted simply and can be detected.
[0159] There is no example which noted that a charge was spread in the direction of a field and distribution of voltage deteriorated conventionally by the direct-current-resistance component which the dielectric reflective film has, and it raised the spatial resolving power of distribution of voltage by this approach by impressing a periodic 0 sum electrical potential difference, for example, alternating voltage, to the circuit pattern of the circuit board.
[0160] When the incident wave length to an electro-optics component is restricted especially, sensibility is shown in vertical electric field as an electro-optics crystal, for example, the distribution of voltage of a circuit pattern can be detected with sufficient spatial resolving power by using BSO crystal. Moreover, diffusion of the charge generated in the direction of a field in the laminated structure of an electro-optics component by impressing alternating voltage to a circuit pattern is prevented, and the spatial resolving power of distribution of voltage increases.
[0161] As the light source, it is using incoherent light with the large quantity of lights, such as halogen light and METAHARA light, for example, and a S/N ratio is raised and effect of interference can be lessened.
[0162] When the white light is used as incident light to an electro-optics component at this time, for example, since BSO crystal has the photoconductive effect, resistance falls. If periodic 0 sum electrical potential differences, such as alternating voltage, are furthermore impressed, the capacitive load which joins the dielectric reflective film etc. will fall, and it will become easy to produce damages, such as dielectric breakdown, on the dielectric reflective film etc. The fall of a capacitive load which joins the dielectric reflective film etc. can be prevented by removing the wavelength from which a wavelength filter restricts the incident light to an electro-optics component, for example, electro-optics components, such as BSO crystal, produce the photoconductive effect paying attention to this point.
[0163] In addition, since there is an electro-optics component when it is desirable to become the layer structure from which a refractive index differs, reflection arises between layers and it becomes easy to generate interference. Then, by preparing acid-resisting processing which negates reflection between

layers, interference can be lessened and the distribution of voltage of a circuit pattern can be detected with sufficient spatial resolving power.

[0164] Furthermore, the dielectric reflective film can reflect only specific wavelength. Therefore, if incidence of the light of the other wavelength is carried out to an electro-optics component, when the circuit board will be detected by the photodetector as an image and it will detect distribution of voltage, the nonuniformity of sensibility arises with a location in the case of the detection. Then, an electrical potential difference is detectable by uniform sensibility restricting incident light to the wavelength which the dielectric reflective film etc. reflects.

[Translation done.]

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block block diagram showing one example of this invention.
[Drawing 2] The explanatory view showing the principle which inspects an open circuit and short circuit of the circuit board from an electric-field image.
[Drawing 3] The flow chart which carries out electric inspection of the circuit board from an electric-field image.
[Drawing 4] It is the representative circuit schematic (a) and its electrical-potential-difference wave form chart (b) of an example of drawing 1 .
[Drawing 5] Having the example of drawing 1 , and a common block block diagram, the examples of drawing 4 are the impression wave form chart (a) of another example, and (b).
[Drawing 6] Having the example of drawing 1 , and a common block block diagram, the examples of drawing 4 and drawing 5 are the impression wave form chart (a) of another example, and (b).
[Drawing 7] Having the example of drawing 1 , and a common block block diagram, the examples of drawing 4 , drawing 5 , and drawing 6 are the impression wave form chart (a) of another example, (b), (c), (d), and (e).
[Drawing 8] It is the block block diagram showing another example with the example of drawing 1 .
[Drawing 9] They are drawing 1 and the block block diagram showing another example with the example of drawing 8 .
[Drawing 10] It is drawing showing the change of an electrical-potential-difference-light strength property when putting in 1/8 wavelength plate in the case of the example of drawing 9 .
[Drawing 11] They are drawing 1 , drawing 8 , and the block block diagram showing another example with the example of drawing 9 .
[Drawing 12] It is the sectional view of drawing 1 , drawing 8 , drawing 9 , and the electro-optics component of an example other than the example of drawing 11 .
[Drawing 13] They are drawing 1 , drawing 8 , drawing 9 , drawing 11 , and the block block diagram showing another example with the example of drawing 12 .
[Drawing 14] They are drawing 1 , drawing 8 , drawing 9 , drawing 11 , drawing 12 , and the block block diagram of an example other than the example of drawing 13 R> 3.
[Drawing 15] They are drawing 1 , drawing 8 , drawing 9 , drawing 11 , drawing 12 , drawing 13 R> 3, and the top view (a) and sectional view (b) to be examined showing another example with the example of drawing 14 .
[Description of Notations]
1 -- Electro-optics component
1-1 -- Dielectric reflective film
1-2 -- Electro-optics crystal
1-3 -- Transparent electrode
1-4 -- Adhesives layer
1-5 -- Transparence substrate

1-6 -- Pair adhesives antireflection film
1-7 -- Pair transparent electrode antireflection film
1-8 -- Pair transparence substrate antireflection film
1-9 -- Antiaircraft mind antireflection film
2 -- Circuit board
2-1 -- Circuit pattern
3 -- Source of a signal
4 -- Laser light source
5 -- Beam expander
6 -- Polarizer
7 -- Beam splitter
8 -- Analyzer
9 -- Photodetector
10 -- Analysis equipment
11 -- Control unit
12 -- Source of a signal
13 -- 1/8 wavelength plate
14 -- 1/8 wavelength plate
21 -- Circuit pattern
22 -- Electro-optics component
23 -- Excellent article electrical characteristics electric-field image
24 -- Electric-field image with faulty electrical characteristics
25 -- Short circuit section
26 -- Open-circuit section
28-35 -- Processing
41 -- Wavelength filter

[Translation done.]

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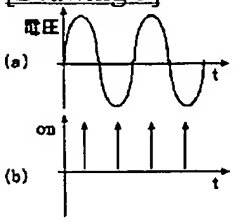
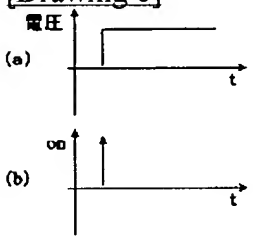
DRAWINGS

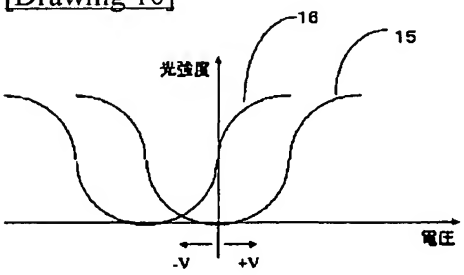
[Drawing 5]



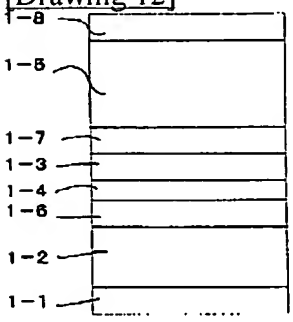
[Drawing 6]



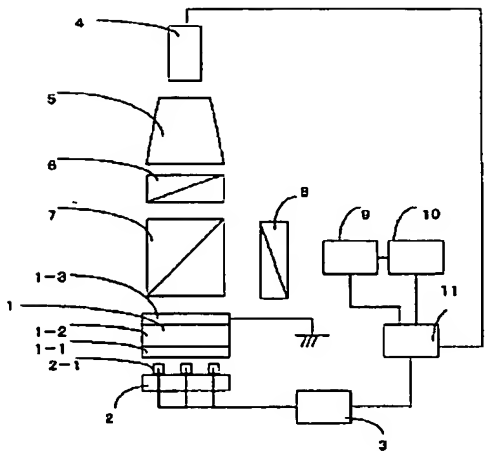
[Drawing 10]



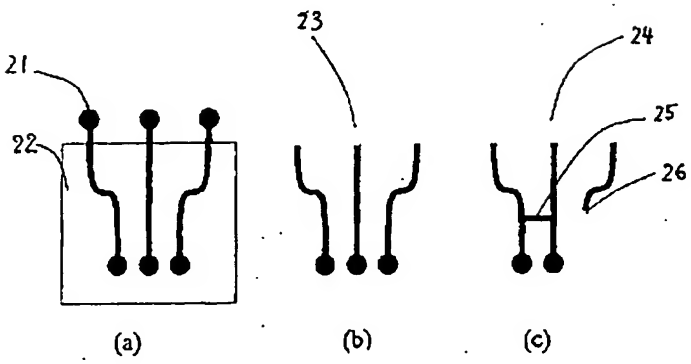
[Drawing 12]



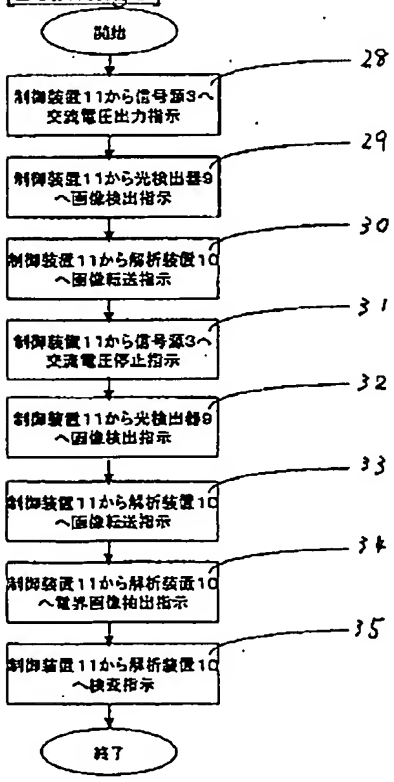
[Drawing 1]



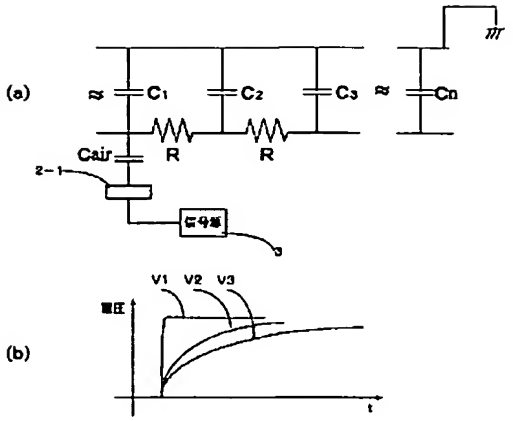
[Drawing 2]



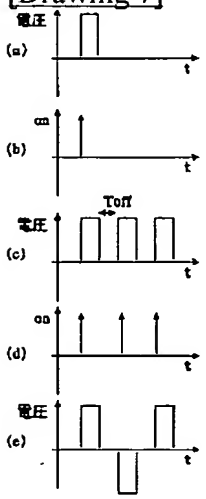
[Drawing 3]



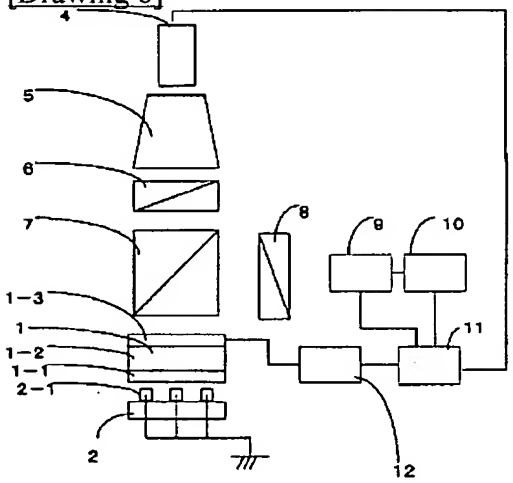
[Drawing 4]



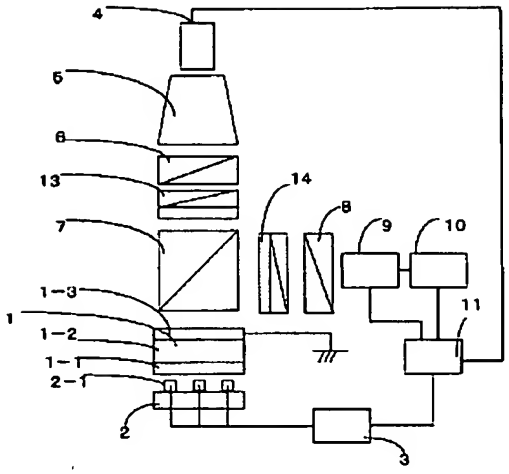
[Drawing 7]



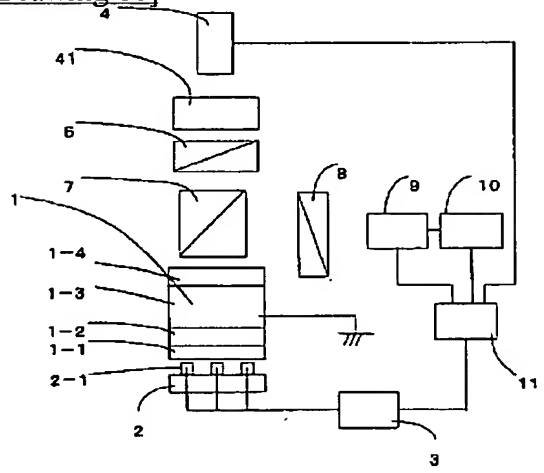
[Drawing 8]



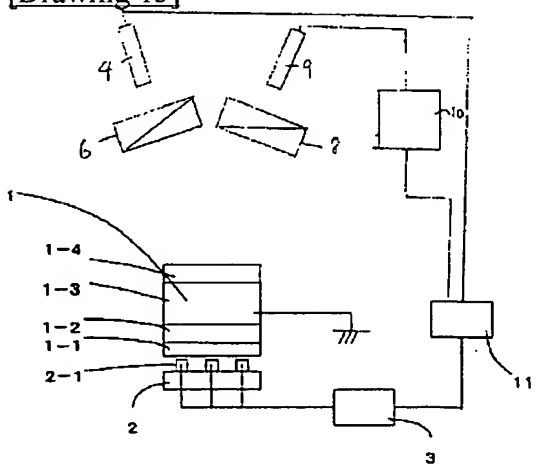
[Drawing 9]



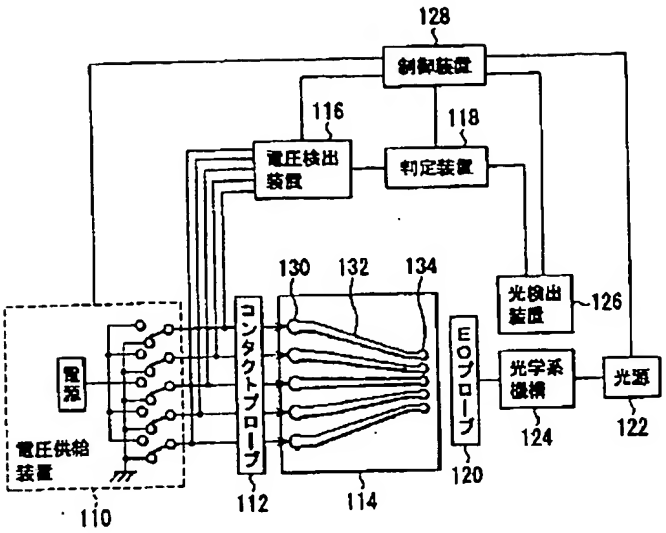
[Drawing 11]



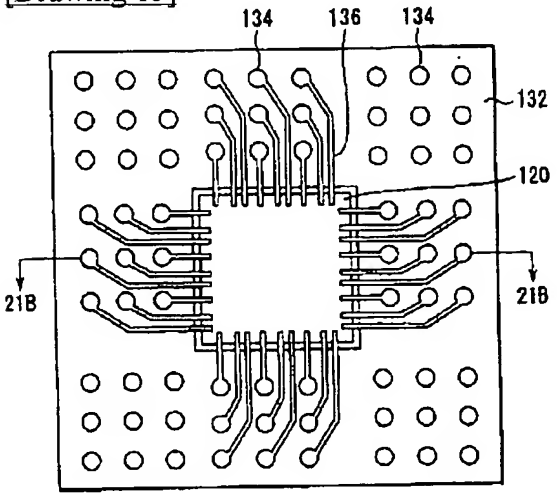
[Drawing 13]



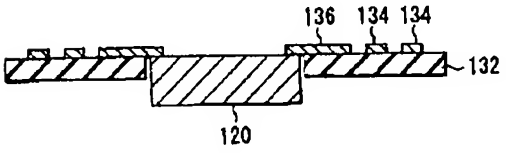
[Drawing 14]



[Drawing 15]



(a)



(b)

[Translation done.]